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STRONG AND SOFT NONWOVEN FABRIC

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[Attached amendments have been incorporated into text of translation.]

Claims

1. A type of nonwoven fabric characterized by the fact that the nonwoven fabric is reinforced with spot bonding portions of fibers from the outer surface to inner surface of the web and in an arbitrary pattern over the entire surface of the web, and it has non-bonded recess/projection deformation portions formed in an arbitrary shape over the entire surface of the web.

2. The nonwoven fabric described in Claim 1 characterized by the fact that the web is made of long fibers.

3. The nonwoven fabric described in Claim 1 characterized by the fact that the spot bonding portions are formed by thermocompression bonding.

4. The nonwoven fabric described in Claim 3 characterized by the fact that an adhesive is applied over the entire surface of the web so as hold the lint in place.

5. The nonwoven fabric described in Claim 1 characterized by the fact that the spacing between the spot bonding portions is in the range of 0.5-10 mm, and the proportion of the spot bonding portions in area is in the range of 5-60%.

6. The nonwoven fabric described in Claim 1 characterized by the fact that the non-bonded recess/projection deformation portions have a depth in the range of 0.1-5.0 mm, and the pitch of the recess/projection deformation portions is in the range of 0.5-10 mm.

7. The nonwoven fabric described in Claim 1 characterized by the fact that the non-bonded recess/projection deformation portions are recesses/projections of small wrinkle shape.

8. A method for manufacturing nonwoven fabric characterized by the fact that on a continuously manufactured web, the spot bonding portions of fibers are formed in an arbitrary pattern, and the web is then molded into recesses/projections of arbitrary shape.

9. The method for manufacturing nonwoven fabric described in Claim 8 characterized by the fact that smoothing treatment is performed after molding of recesses/projections.

#### Detailed explanation of the invention

The present invention pertains to a type of nonwoven fabric that is strong, free of linting, and soft, as well as its manufacturing method.

Nonwoven fabrics in wide use in recent years have been inexpensive since there is no need to employ weaving/knitting operations using metal parts. However, the properties, especially strength and feel, are poorer than those of woven/knit fabrics.

Nonwoven fabric differs from woven/knit fabrics, which maintain strength by means of the knit or woven tissue, in that its strength is maintained by directly bonding and fixing individual fibers in the web, which is a collection of short and long fibers with uneven lengths.

In order to directly bond the fibers with each other, several schemes can be adopted. These include using an adhesive, using an adhesive as well as needle punching, and thermocompression bonding. When using an adhesive, there are the following schemes: full-surface bonding in which the web is dipped in the adhesive liquid, or the adhesive is sprayed over the entire surface of the web, and a spot bonding method in which a hot melt adhesive is used to perform point-wise bonding. Thermocompression bonding is adopted for webs made of thermoplastic fibers. Just as with adhesives, there is a scheme of full-surface thermocompression

bonding and a scheme of partial thermocompression bonding. Here, spot bonding refers to the scheme in which a prescribed pattern is pressed on the web, and the fibers are bonded to each other throughout the web from the outer surface to the inner surface by adhesion or welding, while the fibers in the remaining portion outside the pattern are not bonded to each other. The spot bonding method can make the nonwoven fabric softer than the full-surface bonding method. However, even with the spot bonding method, if the nonwoven fabric is treated to have a high enough strength and the surface linting is suppressed, the density of the spot bonding portions becomes rather high for the obtained pattern. The softness of such patterns of spot bonding of nonwoven fabric is insufficient in the prior art, and the obtained nonwoven fabric becomes hard, with a softness unlike that of the feed fibers themselves.

Taking the aforementioned problems into consideration, the present inventors have engaged in extensive research into development of a type of nonwoven fabric that has a sufficiently high strength, is free of linting, and at the same time, has an improved soft feel. Possible schemes include using an adhesive that is as soft as possible; formation of spot bonding patterns that can improve opposing properties, that is, increasing strength, preventing linting, and improving softness; and development of press bonding technology that can eliminate the semi-bonding effect on the web fibers in portions other than the spot bonding portions of the pattern. However, all of these schemes have certain limits in improving softness. The research by the present inventors has revealed that by performing an extremely simple post-treatment on nonwoven fabric fixed using the spot bonding method, it is possible to improve the softness significantly while maintaining the strength and the fluff generation characteristics. The present invention was achieved as a result.

That is, the present invention provides a type of nonwoven fabric characterized by the fact that the nonwoven fabric is reinforced with spot bonding portions of fibers from the outer surface to inner surface of the web and in an arbitrary pattern over the entire surface of the web, and it has non-bonded recess/projection deformation portions formed in an arbitrary shape over the entire surface of the web.

In order to obtain the nonwoven fabric of the present invention, the nonwoven fabric, which has been treated by means of thermocompression bonding or pressing with an adhesive to form an appropriate pattern, is allowed to pass between rolls having an appropriate pattern of recesses/projections, so that the nonwoven fabric is molded to an appropriate shape without a bonding or setting effect on the fibers.

As will be explained in the later application examples and comparative examples, the softness of the nonwoven fabric of the present invention can be improved significantly, with 5% change in numerical values pertaining to the modulus, rigidity/softness, etc., and with little change in the strength and linting condition. Also, the feel clearly indicates improvement in the

softness. The obtained nonwoven fabric seems to be as soft as the fibers themselves. This state has been confirmed with cross-sectional micrographs shown in the figures.

It is believed that the aforementioned unexpected excellent effects are due to the following reasons. That is, in the spot bonding method using adhesive or thermocompression bonding, the virtual bonding effect, setting effect, etc. become non-negligible in the fibers in portions other than the spot bonding portions of the web. The amount that said effects contribute to the hardness of the nonwoven fabric is more than people thought. If said effects can be eliminated to sufficiently free the fibers of said portions other than the spot bonding portions, even when a significant proportion of spot bonding portions is formed to improve strength and control linting, the freedom of the fibers in the non-bonding portions can still be exhibited, so that the intrinsic softness of the fibers can be displayed. As a result, the softness of the obtained nonwoven fabric can be improved significantly.

The present invention also includes nonwoven fabric that is reinforced with spot bonding portions, followed by attachment of a small quantity of adhesive on the surface of the web. Because the adhesive is attached to the surface of the web, lint on the surface of the nonwoven fabric can be even better suppressed. Also, the form can be maintained more easily in molding processes. These are effects of the treatment.

The present invention will be explained in more detail in the following.

There is no special limitation on the type of fibers used as the feed material for the nonwoven fabric of the present invention, and almost any type of fibers may be used. However, when thermocompression bonding is adopted as the means of spot bonding, the web should be made of thermoplastic fibers or a fiber mixture mainly containing said thermoplastic fibers. Examples of thermoplastic synthetic fibers include fibers made of nylon 6, nylon 66, nylon 6-10 and other polyamide based polymers and copolymers, polyethylene terephthalate and other polyester based polymers and copolymers, polyester ether based polymers, polyethylene, polypropylene, poly-4-methyl pentene-1 and other polyolefin based polymers, polyvinyl chloride, polyvinylidene chloride and other polyvinyl halide polymers and copolymers, etc.; blends of these various types of polymers; composite fibers prepared by bonding said fibers; etc. Also, two or more types of fibers may be blended to form the web. In addition, the fibers for forming the web may be long fibers, whiskers, or their blend. Cellulose-based fibers may be used as the fibers for blending. However, in the case of thermocompression bonding, it is preferred that the proportion of said cellulose-based fibers not be over 50%. When an adhesive is used in pressing bonding, the fibers need not be thermoplastic fibers. The denier of the fibers should be selected carefully as it significantly affects the softness, strength, etc., of the nonwoven fabric. Usually, the denier of the fibers should be in the range of 0.5-10 denier. The finer the fibers, the better the softness. Conversely, the bigger the fibers, the higher the strength. Consequently, it is

preferred that the denier value be in the range of 0.5-5% obtain soft nonwoven fabrics, with the specific value depending on the specific application.

Types of webs include the so-called whisker web prepared using a carding method, paper forming method, air laying method, etc., and the so-called long fiber web prepared using a method of opening of tow-like fibers, the spunbonding method in which the spun fibers are directly formed into a web shape, etc.

In particular, the long fiber web is preferred to realize a high strength.

The nonwoven fabric of the present invention is reinforced by means of spot bonding portions of fibers formed throughout the web from the outer surface of the web to the inner surface of the web in an arbitrary pattern over the entire surface of the web. The form of the bonding is illustrated with the schematic cross sectional shown in Figure 1. As shown in the figure, (1) represents the bonding portions, and (2) represents the non-bonding portions. The pattern of the spot bonding portions is shown in Figures 2 and 3 as examples. In Figure 2, the spot bonding portions are short linear shapes arranged in a zigzag configuration. In Figure 3, square spot bonding portions are densely formed in an almost continuous configuration. In addition to these patterns, other patterns can be adopted, such as a continuous pattern with no spaces between the spot bonding portions, and a discontinuous pattern with spaces between the spot bonding portions. The shape of the pattern is determined to ensure that the nonwoven fabric has sufficiently high strength and little linting. Also, it is important to consider the need to exhibit the improved effect softness in later molding of non-bonding recess/projection deformation. The proportion by area of the pattern on the web should be in the range of 5-60% to be effective. As the proportion by area becomes smaller, or as the spacing between the spot bonding portions becomes larger, the softness becomes better and linting becomes more significant. The spacing between the spot bonding portions should be 0.3 mm or greater, or preferably in the range of 0.5-10 mm.

The spot bonding methods include thermocompression bonding and pressure bonding using an adhesive. Spot bonding by thermocompression bonding is usually realized by processing between thermocompression plates having recess/projection patterns on their surfaces, or between a pair of thermocompression rolls. In this case, one of the plates or rolls may be smooth. Also, as needed, a flexible roll may be used as one of said rolls. The conditions of the thermocompression bonding operation should be determined appropriately according to the type of fibers used. It is necessary to ensure that bonding is sufficient so that no separation of the bonding portions occurs in the later non-bonding recess/projection deformation treatment. Usually, the temperature also depends on the type of fibers. It is preferred that the temperature be in the range of 5°C-50°C below the melting point of the fibers, and it should be determined appropriately in combination with the applied pressure.

Also, when an adhesive is used, the so-called gravure roll method and printing method may be adopted.

The most significant characteristic feature of the present invention is that it has spot bonding portions and that the non-bonding recess/projection deformation is applied to the partially bonded sheet. In other words, the sheet is molded for recesses/projections. The shape of the molded recesses/projections, and the size and depth (height) of the unit recesses/projections are related to the spot bonding pattern and are important factors in improving the softness. Examples of shapes include straight linear shapes, curved shapes, square shapes, round shapes, crepe shapes, and other continuous or discontinuous shapes, which may be used either alone or as a mixture of several types.

The softness effect depends on a combination of the depth, pitch and configuration of the recesses/projections, and it cannot be simply described. Generally speaking, the larger the depth of the recesses/projections, the greater the softness effect, and the larger the size of the unit recesses/projections, the greater the softness effect. It is preferred that the depth be about 0.1-5.5 mm, and the size (pitch) of the unit recesses/projections be about 0.5-10 mm.

As shown in the oblique views of Figures 4, 5, 6, the molded recess/projection shape may be regular or irregular. The projecting portions are discontinuous projections formed on a plane in the pattern shown in Figure 4. The recesses/projections are formed alternately in a continuous pleated shape in the pattern shown in Figure 5. Small engraved wrinkles are formed as the recesses/projections in the pattern shown in Figure 6. Although there is no need to specially consider correlation of the shape, configuration, etc., of the molded recess/projection portions and the spot bonding portions, one may also adopt a configuration in which the bonding portions are fitted to the non-thermoccompression bonding portions as needed.

With regard to the method for molding the recesses/projections, for example, the sheet is usually treated by passing it between rolls or plates having recess/projection patterns on their surfaces that fit each other well. Also, as a special method, one may forcibly over-feed the nonwoven fabric through a small gap between two rolls at a prescribed over-feeding rate so as to form small wrinkle-like molded shapes.

Also, factors that require special attention as the conditions for molding recesses/projections include the over-feed rate during processing, the treatment temperature and the pressure applied to the nonwoven fabric during processing. That is, the softness depends significantly on the ratio of the feeding speed and removal speed of the nonwoven fabric during processing, as well as its sag. As the feeding speed is increased, sag occurs, and significant folding effects take place inside the recess/projection mold. However, in treatment of nonwoven fabric without sag and with a tension applied to it, for example, when continuous molding of recesses/projections is performed, not only is a folding effect displayed, but also a stretching

effect is added in the recess/projection portions. The treatment temperature is usually room temperature. However, as needed, one may apply steam or hot water to give it plasticity and make it easily moldable, or treatment may be performed at a temperature in a range in which bonding and setting of fibers do not take place so as to guarantee the stability of the form. The pressure during processing also depends on the temperature. Of course, the pressure should be set appropriately to ensure sufficient molding. Also, when said molding is performed sufficiently, deformation occurs in the fiber cross section of the compressed portions. Due to the partial deformation effect, however, treatment at an even higher pressure is effective in order to display even better softness. In this case, the pressure should be selected to correspond to the specific application. Of course, attention should be paid to conditions to ensure that fixing and thermocompression bonding of the fibers in the compressed portions do not essentially occur.

Also, the nonwoven fabric of the present invention includes the type prepared by flattening treatment after said molding of recesses/projections.

Figure 7 is an oblique view illustrating an example of the nonwoven fabric of the present invention. (1) represents the spot bonding portions, and (2) represents the non-pressed/bonded portions. The front portion shows the cross section. Regular wavy recesses/projections are molded. The pitch of the recesses/projections is significantly smaller than the unit length of the spot bonding portions.

Figure 8 is a cross-sectional view illustrating a nonwoven fabric which is molded into a regular wavy shape and has a pitch much larger than the unit length of the bonding portions.

Also, as needed, a softening agent, permeating agent, flame retarding agent, etc., can be applied to the nonwoven fabric of the present invention. Also, chemicals may be applied to maintain the molded recesses/projections, and an adhesive may be applied to suppress lint. In such cases, of course, application should be performed appropriately to ensure that no strong fixing takes place. For example, when an adhesive is applied, the quantity depends on the softness of the resin. When a soft nonwoven fabric is required, the quantity of adhesive applied should be 30% or less. Also, in practice, said treatments may be performed on the fibers, or after spot bonding of the web shape, or as the final step of processing. Usually, treatment with adhesive or the like is performed in combination with the partial thermocompression bonding method.

In the following, the present invention will be explained in more detail with reference to application examples.

#### Application Example 1

A polyester long fiber web prepared using the spunbonding method (with 1d filaments and a metsuke of 50 g/m<sup>2</sup>) was processed by feeding between an embossed roll (embossing depth



of 0.4 mm) having the pattern shown as (1) in Figure 2 and a flat-surface metal roll, both heated at 230°C, to form a partially thermocompression-bonded web. The web was then pressed at room temperature between a recess/projection roll having a staggered pattern composed of projections with a height of 3 mm, a pitch of 5 mm and a 1 mm square apex and a paper roll having the same molding pattern. Processing was performed at a pressure of 20 kg/cm<sup>2</sup>. The nonwoven fabric obtained exhibits the thermocompression bonding portions shown in Figure 9, and is a soft nonwoven fabric with the staggered pattern over its entirety at a pitch of 5 mm. Its cross-sectional form is shown in Figures 10 and 11 (Figure 11 is an enlarged view of Figure 10). Compared with the nonwoven fabric in the partially thermocompression-bonded state as shown in Figure 12 (a plan view), Figure 13 (a cross section), and Figure 14 (an enlarged view of Figure 13), the aforementioned cross-sectional form exhibits only a lower-order fixing of the fiber layer of the non-pressed/bonded portions corresponding to the molding projections, the nonwoven fabric is in a bulky state, and the pressed/bonded portions are found to be bent. When further pressure is applied to the fibers, irregular deformation takes place so that they become flat. The bulky state due to the fiber layer of the non-pressed/bonded portion and the bent state of the pressed/bonded portions can be seen in the portions other than the projections, that is, in the so-called flat portions. Figure 14 is an enlarged photograph illustrating the nonwoven fabric prepared by spot bonding treatment with thermocompression bonding and without molding to create recesses/projections. It can be seen that both the non-pressed/bonded portions and pressed/bonded portions have the straight fibers arranged in them as is. It is believed that the difference in the state between Figures 11 and 14 is displayed clearly as a difference in the softness between the two nonwoven fabrics. The properties of the nonwoven fabric of the present invention are listed in Table 1. Compared with the nonwoven fabric prepared only with partial thermocompression bonding, the nonwoven fabric of the present invention has a larger apparent thickness, the same or higher strength, and better softness.

Table 1									
	① 厚み [mm]	② 引張強さ (kg/3cm幅)		③ 伸 度 %		④ 5%モジュラス (kg/3cm幅)		⑤ 引張強さ (kg)	
		タテ	ヨコ	タテ	ヨコ	タテ	ヨコ	タテ	ヨコ
⑥ 本発明不織布	0.89	1.03	4.5	29	34	2.7	1.4	2.1	1.0
⑦ 実施例1で 熱圧着したままのもの	0.38	9.6	5.1	29	38	4.6	2.3	1.3	0.7

Key: 1 Thickness  
2 Tensile strength (kg/3-cm width)

- 3 Elongation
- 4 5% modulus (kg/3-cm width)
- 5 Rupture strength
- 6 Nonwoven fabric of the present invention
- 7 Nonwoven fabric in Application Example 1 prepared with only thermocompression bonding
- 8 Lateral
- 9 Longitudinal

Here, the tensile strength was measured according to JIS-L-1068 (strip method), and the rupture strength was measured according to JIS-L-1085 (pendulum method). The thickness was measured using a Peacock type thickness meter to determine the apparent thickness with no load applied. The 5% modulus indicates the strength at 5% elongation as shown on the stress-strain curve. The lower this modulus, the better the softness.

### Application Example 2

The same partially thermocompression-bonded web as that in Application Example 1 was subjected to recess/projection molding processing between an embossed roll having a pattern of linear recesses/projections (a size of 1 mm and a pitch of 2.5 mm) running obliquely (45°) and a paper roll having a pattern matching said embossed pattern. Treatment was performed at 150°C and a pressure of 50 kg/cm<sup>2</sup>. The nonwoven fabric obtained has the molded shape shown in Figure 15 (a plan view), Figure 16 (a cross section) and Figure 17 (an enlarged view of Figure 16). As can be seen from these figures, fiber deformation clearly takes place in the compressed portions. In particular, the fibers are prone to bending in the direction perpendicular to the molding line. The obtained nonwoven fabric has improved overall softness.

The properties of the obtained nonwoven fabric are listed in Table 2.

Table 2									
⑥	① 厚み (mm)	② 引張強さ (kg/3cm幅)		③ 伸 率 (%)		④ 5%モジュラス (kg/3cm幅)		⑤ 引裂強さ (kg)	
		タ ⑧	コ ⑨	タ ⑧	コ ⑨	タ ⑧	コ ⑨	タ ⑧	コ ⑨
		⑧		⑨		⑩		⑪	
	0.65	9.5	40	17	33	21	11	29	24

- Key:
- 1 Thickness
  - 2 Tensile strength (kg/3-cm width)
  - 3 Elongation
  - 4 5% modulus (kg/3-cm width)
  - 5 Rupture strength
  - 6 Nonwoven fabric of the present invention

- 8 Lateral  
9 Longitudinal

As a comparison, a paper-like web with a pattern obtained by processing the web in Application Example 1 between two heated flat metal rolls without partial thermocompression-bonding processing was subjected to the same molding processing for forming recesses/projections using the same aforementioned embossed roll. It was found that just as in paper processing, although bending is somewhat easy in the direction perpendicular to the molding line, the web obtained is hard and coarse.

In order to realize added value in practical applications of the nonwoven fabric of the present invention, one may apply static inhibitors, permeating agents, friction-resistance improving agents, etc., either before or after the molding processing to form recesses/projections. In these cases, there is no significant change in the characteristics, and the nonwoven fabric obtained has excellent softness.

### Application Example 3

The same partially thermocompression-bonded web as that in Application Example 1 was press-processed using a rubber roll and a metal roll to form the small-wrinkle molding pattern shown in Figure 6. A soft nonwoven fabric was obtained as a result. As can be seen from Figures 18, 19, 20, compared with the nonwoven fabric prepared with only partial thermocompression bonding the fiber layer is bulky, and the fibers themselves are found to be bent in the non-pressed/bonded portions of this nonwoven fabric. On the other hand, although there is no bulky state, the fibers are found to be bent in the pressed/bonded portions. By simply comparing the figures, one can see that the nonwoven fabric of the present invention, while having the same thermocompression-bonded portions, is softer overall.

The properties of the nonwoven fabric are listed in Table 3.

Table 3

	① 厚さ (mm)	② 引張り力 (kg/3cm幅)		③ 厚さ (mm)		④ 伸縮率 (%/3cm幅)		⑤ 引張り力 (kg)		⑥ 厚さ (mm)	
		⑨ 縦向き		⑩ 横向き		⑨ 縦向き		⑩ 横向き		⑨ 縦向き	
		⑨	⑩	⑨	⑩	⑨	⑩	⑨	⑩	⑨	⑩
⑦ 本発明不織布	0.47	7.2	6.3	9.9	8.0	0.2	1.3	2.1	1.3	9.8	6.4
⑧ 実例1で 蒸汗処理したもの	0.38	9.4	5.1	2.9	3.8	8.4	2.3	1.3	0.5	10.0	10.7

Key: 1 Thickness  
2 Tensile strength (kg/3-cm width)

3	Elongation
4	5% modulus (kg/3-cm width)
5	Rupture strength
6	Bending resistance
7	Nonwoven fabric of the present invention
8	Nonwoven fabric in Application Example 1 prepared with only thermocompression bonding
9	Lateral
10	Longitudinal

The bending resistance was measured according to JIS-L-1085 (cantilever method). From the values of the 5% modulus and bending resistance, it can be seen clearly that the nonwoven fabric of the present invention is sufficiently soft.

Also, as a comparison, the web without sufficient partial thermocompression bonding as in Application Example 1 (nonwoven fabric processed at the same pressure and at 100°C) was press-processed. However, because thermocompression bonding was not performed, problems develop. For example, the fibers as a whole may expand to return to the state of the original web, and it may become caught in the device.

As explained above, by means of sufficient partial thermocompression bonding processing, the nonwoven fabric of the present invention can be given sufficiently high strength, and at the same time, the fibers in portions other than the partially thermocompression-bonded portions are given greater freedom, so that the nonwoven fabric is soft.

In addition, in order to suppress lint in the non-pressed/bonded portions of the partially thermocompression-bonded web, a small quantity of polyacrylate based adhesive was applied (adhesive with a commercial name of MOVINYL [transliteration] 962 (with a solids content of 40%, manufactured by Hoechst Synthesis Co., Ltd.) coated using a roll coater, followed by drying and heat treatment. The solids content is about 6 g/m<sup>2</sup>, and the nonwoven fabric obtained was press-processed in the same way as described above. As a result, loosening of the fibers of the non-pressed/bonded portions is reduced compared to the nonwoven fabric without adhesive applied, linting is less significant, and the softness is excellent.

The properties of the nonwoven fabric are listed in Table 4.

Table 4											
	① 厚み (mm)	② 張力 (kg/3cm幅)		③ 破断伸度 (%)		④ 5%モジュラス (kg/3cm幅)		⑤ 引裂強度 (kg)		⑥ 剛軟度 (mm)	
		⑨ ⑩		⑨ ⑩		⑨ ⑩		⑨ ⑩		⑨ ⑩	
		⑨	⑩	⑨	⑩	⑨	⑩	⑨	⑩	⑨	⑩
⑦ 本発明の不織布	0.43	9.1	5.8	37	33	0.7	1.3	1.2	1.3	53	74
⑧ 熱圧縮縫毛糸状 粘着剤付与	0.36	10.3	5.5	25	23	4.8	2.5	1.1	0.4	127	132

- Key:
- 1 Thickness
  - 2 Tensile strength (kg/3-cm width)
  - 3 Elongation at rupture
  - 4 5% modulus (kg/3-cm width)
  - 5 Rupture strength
  - 6 Bending resistance
  - 7 Nonwoven fabric of the present invention
  - 8 Nonwoven fabric with adhesive applied to suppress lint
  - 9 Lateral
  - 10 Longitudinal

As a result, a strong nonwoven fabric with excellent softness and free of linting was obtained.

#### Application Example 4

The same type of web as that in Application Example 1 was treated by printing with the pattern shown in Figure 2 instead of by partial thermocompression bonding treatment. A polyacrylate based adhesive was used. After drying and heat treatment, the web was processed by molding to form recesses/projections, just as in Application Example 1. As a result, although the adhesive has a certain feel characteristic, the softness is much more significant than that before molding. The same effects as those in Application Example 1 can be realized.

#### Application Example 5

A web made of nylon-6 long fibers (1.5 d filament size, metsuke of 45 g/m<sup>2</sup>) prepared using the spunbonding method was processed between an embossed roll heated to 190°C and having the woven-stitch pattern shown in Figure 3 (with embossed depth of 0.3 mm) and a paper roll, forming a partially thermocompression-bonded web. The web was then press-processed in the same way as Application Example 3 to mold small-sized wrinkles. As a result, the same excellent soft nonwoven fabric was obtained as that in Application Example 3.

The data listed in Table 5 shows that the strength is sufficient.

Table 5									
	① 厚み (mm)	② 引張強力 (kg/3cm幅)		③ 伸 度 (%)		④ 引裂強力 (kg)		⑤ 耐 皺 度 (mm)	
		⑧	⑨	⑧	⑨	⑧	⑨	⑧	⑨
⑥ 本発明不織布	0.35	113	35	31	31	0.6	0.4	3.6	4.3
⑦ 実施例5の 熱圧着したものの	0.22	120	31	33	28	0.7	0.3	4.3	7.5

- Key:
- 1 Thickness
  - 2 Tensile strength (kg/3-cm width)
  - 3 Elongation
  - 4 Rupture strength
  - 5 Bending resistance
  - 6 Nonwoven fabric of the present invention
  - 7 Nonwoven fabric in Application Example 5 processed with only thermocompression bonding
  - 8 Lateral
  - 9 Longitudinal

As another test, the partially thermocompression-bonded web was fed between an embossed roll with small-wrinkle shaped molding embossments (0.5 mm deep) and a rubber roll at room temperature and a pressure of 30 kg/cm<sup>2</sup> as another process step. As a result, a nonwoven fabric with nearly the same feel and properties as those of the aforementioned press-processed nonwoven fabric was obtained. This shows that softness can be realized by molding even when a different molding method is adopted.

The properties of the nonwoven fabric of the present invention prepared by treatment using said small-wrinkle shaped embossed roll are listed in Table 6.

Table 6									
	① 厚み (mm)	② 引張強力 (kg/3cm幅)		③ 伸 度 (%)		④ 引裂強力 (kg)		⑤ 耐 皺 度 (mm)	
		⑦	⑧	⑦	⑧	⑦	⑧	⑦	⑧
⑥ 本発明不織布	0.36	110	33	31	27	0.7	0.3	3.9	4.4

- Key:
- 1 Thickness
  - 2 Tensile strength (kg/3-cm width)
  - 3 Elongation
  - 4 Rupture strength

- 5 Bending resistance
- 6 Nonwoven fabric of the present invention
- 7 Lateral
- 8 Longitudinal

In the method using a recess/projection roll, the compression effect in the thickness direction becomes more significant. Consequently, the volume feels a little smaller, although this cannot be determined from the measurement values in the press-processing. Even when the nonwoven fabric that has been made softer is drawn to stretch at the molded wrinkle shape, there is still no significant change in the softness.

#### Application Example 6

The same nylon-6 long fiber web as that in Application Example 5 (with 3 d filament size a, and a metsuke of 100 g/m<sup>2</sup>) was partially thermocompression-bonded using the same pattern and under the same conditions as in Application Example 1, followed by the same molding treatment as that in Application Example 1. Then, as another process step, the partially thermocompression-bonded web was molded with the same pattern and under the same conditions as those in Application Example 2. Although the properties are changed a little due to this patterned molding, a nonwoven fabric of the present invention with good softness was still obtained.

Table 7

	① 厚み (mm)	② 張強力 (kg/3cm幅)		③ 伸度		④ 引裂強力	
		⑧ テ	⑨ コ	⑧ テ	⑨ コ	⑧ テ	⑨ コ
⑤ 本発明不織布 (実施例1と同型付)	0.93	30.5	123	41	43	1.8	0.9
⑥ 本発明不織布 (実施例2と同型付)	0.70	26.2	106	40	51	1.8	0.7
⑦ 実施例4の 熱圧着したままのもの	0.28	28.0	110	43	48	1.5	0.7

- Key:
- 1 Thickness
  - 2 Tensile strength (kg/3-cm width)
  - 3 Elongation
  - 4 Rupture strength
  - 5 Nonwoven fabric of the present invention (molded in the same way as in Application Example 1)
  - 6 Nonwoven fabric of the present invention (molded in the same way as in Application Example 2)

- 7 Nonwoven fabric of Application Example prepared by thermocompression bonding, 6 as is
- 8 Lateral
- 9 Longitudinal

#### Application Example 7

A web ( $50 \text{ g/m}^2$ ) prepared by carding polyester whiskers (3.5 d filament size, 75 mm length) was fed between the same recess/projection roll as that in Application Example 5 (Figure 8), with a surface temperature of  $235^\circ\text{C}$ , and a roll with a sand-like surface, at the same temperature, for partial thermocompression bonding. Then, just as in Application Example 2, molding of oblique linear shapes was performed just as in Application Example 2, and the web was then reversed, followed by the same molding. As a result, a nonwoven fabric with further improved softness was obtained. As a result of the bending effect in 2 directions and said double treatment for both sides, the effect became even better.

#### Application Example 8

A long-fiber web ( $100 \text{ g/m}^2$ ) made of polyester-based composite fibers (5d filament size, sheath-core type (sheath: isophthalic acid copolymer polyester, m.p. of  $210^\circ\text{C}$ , core: polyethylene terephthalate, m.p. of  $260^\circ\text{C}$ ) prepared using the spunbonding method was fed between an embossed roll with the same pattern as that in Application Example 1 (Figure 2) and a relatively smooth roll with a silk-like surface, with both rolls at a surface temperature of  $200^\circ\text{C}$ , for partial thermocompression bonding. The partially thermocompression-bonded web had the same pattern as that in Application Example 1. Molding treatment was then performed for the obtained partially thermocompression-bonded web between metal rolls with a recess/projection molding shape, at room temperature and a pressure of  $20 \text{ kg/cm}^2$ . As a result, a nonwoven fabric with a soft feel was obtained.

#### Application Example 9

Just as in Application Example 8, a web ( $50 \text{ g/m}^2$ ) made of long polyester fibers (Y-shaped profile yarns, corresponding to about 3.5 d) prepared using the spunbonding method was subjected to partial thermocompression bonding processing and then molding treatment. The obtained nonwoven fabric keeps the characteristic gloss of the Y-shape profile, and is strong and soft.

As can be seen from the application examples presented above, in order to obtain a nonwoven fabric with three excellent properties, that is, strength, [suppressed] fluff, and softness, it is necessary to have both well-bonded partially bonded portions and non-bonded



recess/projection portions. Without both of these two types, the nonwoven fabric of the present invention cannot be obtained. By means of the molding treatment of the present invention, the dense state of the fiber layer is freed in the non-bonded portions, and the fibers of these portions are loosened to form a bulky state. At the same time, the fibers of the nonwoven fabric are stretched and bent overall, and the filaments themselves are also deformed into a flat shape. It is believed that improvement of the softness of the nonwoven fabric of the present invention is due to the aforementioned phenomena.

#### Brief description of the figures

Figure 1 a schematic diagram illustrating the cross section of a partially bonded web. Figures 2 and 3 are schematic plan views each illustrating an example of the pattern of the partially bonded portions.

Figures 4, 5, 6 are schematic oblique views illustrating the state after molding to create recesses/projections.

Figure 7 is a schematic oblique view illustrating an example of the nonwoven fabric of the present invention.

Figure 8 is a schematic cross section illustrating an example of the nonwoven fabric of the present invention.

Figure 9 is a micrograph illustrating a plan view of an example of the nonwoven fabric of the present invention.

Figure 10 is a cross-sectional micrograph of the nonwoven fabric shown in Figure 9.

Figure 11 is an enlarged cross-sectional micrograph of the nonwoven fabric shown in Figure 10.

Figure 12 is a micrograph illustrating a plan view of an example of the nonwoven fabric prepared by only spot bonding corresponding to Figure 11, but without molding to create recesses/projections.

Figure 13 is a micrograph illustrating the cross section of the nonwoven fabric shown in Figure 12.

Figure 14 is an enlarged micrograph of the cross section of the nonwoven fabric shown in Figure 13.

Figure 15 is a plan micrograph illustrating an example of the nonwoven fabric of the present invention.

Figure 16 is a cross-sectional micrograph of the nonwoven fabric shown in Figure 15.

Figure 17 is an enlarged micrograph of the cross section of the nonwoven fabric shown in Figure 16.

Figure 18 is a micrograph illustrating a plan view of an example of the nonwoven fabric of the present invention.

Figure 19 is a cross-sectional micrograph of the same type of nonwoven fabric as that shown in Figure 18.

Figure 20 is an enlarged cross-sectional micrograph of the nonwoven fabric shown in Figure 19.

- 1 Spot bonded portion
- 2 Non-bonded portion



Figure 1

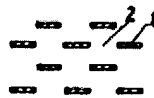


Figure 2



Figure 3

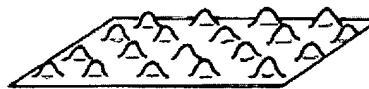


Figure 4



Figure 5



Figure 6

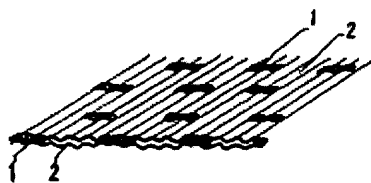


Figure 7



Figure 8



Figure 9



Figure 10

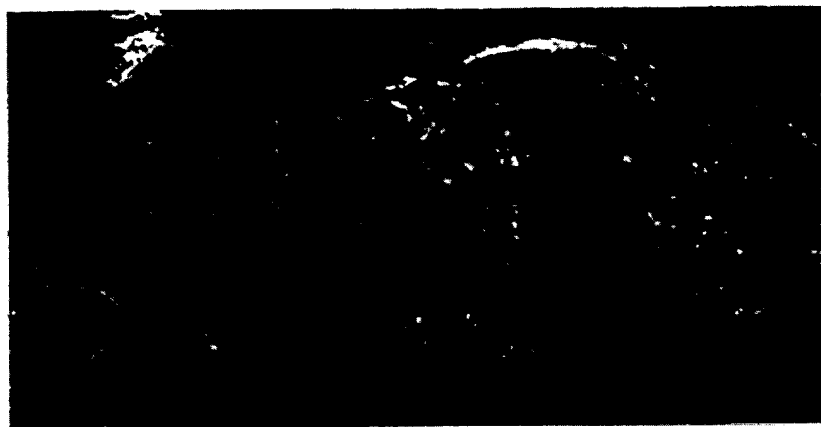


Figure 11

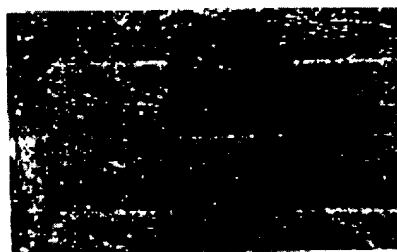


Figure 12

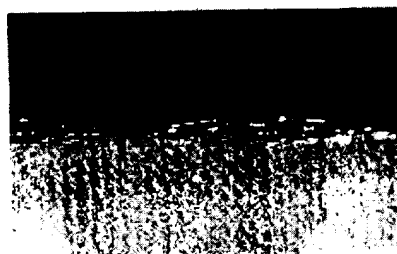


Figure 13



Figure 14

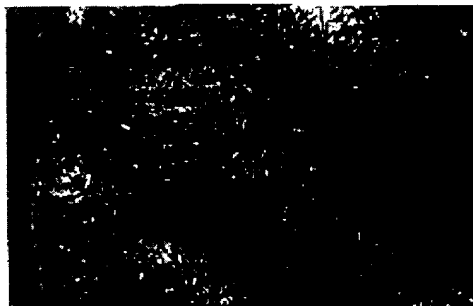


Figure 15

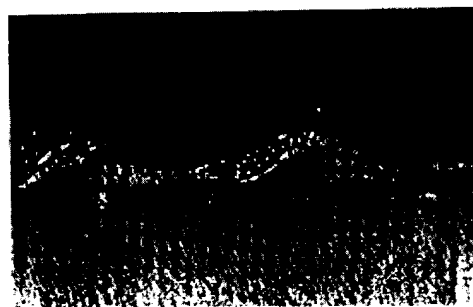


Figure 16



Figure 17



Figure 18

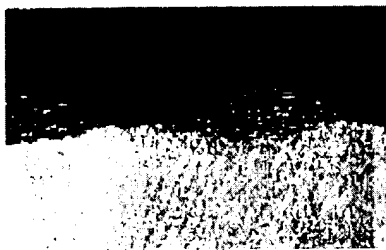


Figure 19



Figure 20

# INTERNATIONAL SEARCH REPORT

International Application No.

PCT/US 98/23887

**A. CLASSIFICATION OF SUBJECT MATTER**  
IPC 6 A61F13/58

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

IPC 6 A61F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 611 789 A (SETH JAYSHREE) 18 March 1997 see column 3, line 57 - column 4, line 47; figure 4	1,3,4, 6-10
X	WO 95 11655 A (MINNESOTA MINING & MFG ;BOYER CHARLES E III (US); RASMUSSEN DAVID) 4 May 1995 see page 13, line 5-35; figures 1,2	1,2,4, 6-10
X	WO 97 26851 A (PROCTER & GAMBLE) 31 July 1997 see page 5, line 15 - page 7, line 18; figures 1,8,9	1,2,4-10
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☒ Further documents are listed in the continuation of box C.

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Date of the actual completion of the international search

26 March 1999

Date of mailing of the international search report

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# INTERNATIONAL SEARCH REPORT

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 324 578 A (MINNESOTA MINING & MFG) 19 July 1989 see column 3, line 42 - column 4, line 28; figures 1-3	1,3,6-10
A	US 3 990 449 A (CHESLOW ERNEST) 9 November 1976 see abstract; figures 1,2,4	1-10



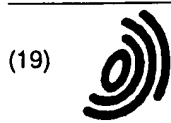
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Information on patent family members

International Application No

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US 3990449 A	09-11-1976	NONE	



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(54) Nonwoven loop member for a mechanical fastener

(57) A loop member for a mechanical fastener comprises a nonwoven web, the nonwoven web having a pattern of intersecting bond lines. The pattern is characterized in that at least a portion comprises a first plurality of non-intersecting continuous bond lines and a second plurality of non-intersecting continuous bond lines, each non-intersecting continuous bond line of the first plurality intersecting each non-intersecting continuous bond line of the second plurality. The intersecting bond lines define unbonded pattern elements, each of the pattern elements being at least partially bounded by

non-linear segments of the bond lines. The bond pattern for a nonwoven web is suitable for use as a loop member of a mechanical fastener. The bond pattern comprises intersecting bond lines having a uniform width and defining a number of bond pattern elements per unit area, wherein at least one of the bond lines is nonlinear, and wherein the ratio of contour to overall bonded area of the bond pattern is greater than a bond pattern comprising all straight lines having the same uniform line width and defining the same number of bond pattern elements per unit area.

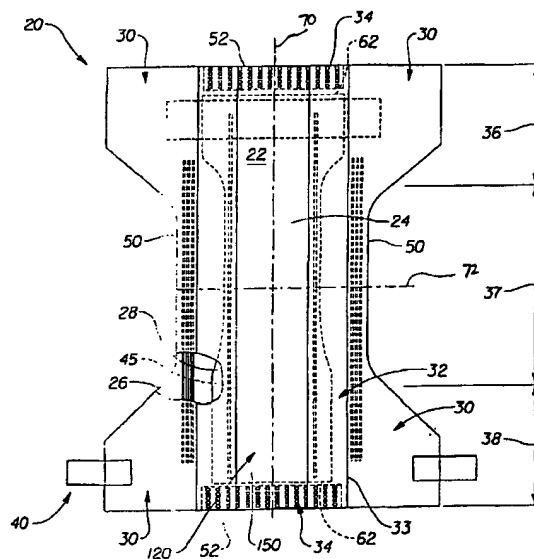


Fig. 1

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